1.1 INTRODUCTION

In an effort to streamline the management of releases and spills from underground storage tanks, The District of Columbia (DC) formed a Stakeholders' Task Force comprised of 21 members. The Task Force was formed based on 63 responses received to an invitation sent earlier to a broad range of potential stakeholders. Based, in part, on the efforts of the Task Force, the first notice of the proposed rule making was published on June 4, 1999 for public comments to be submitted by July 5, 1999. The final notice of rulemaking was published on October 1, 1999, DC Register 4640, 20 DCMR chapter 55 through 70.

This final rulemaking entitled *District of Columbia Underground Storage Tank Regulations* consists of 14 Chapters. These new regulations include the **District of Columbia Risk Based Corrective Action (DCRBCA) or Risk Based Decision Making (DCRBDM)** process. This process can be used to develop site-specific risk based screening levels (RBSLs) and site-specific target levels (SSTLs) for remediation. This approach is supported by the **United States Environmental Protection Agency (USEPA)**.

The DCRBCA process recognizes and balances (i) the need to protect public health, water resources, and the environment of the District, (ii) the variations in site-specific land use and hydrogeological characteristics, (iii) the existing laws and regulations of the District, and (iv) resource limitations. Appropriate risk and exposure assessment practices suggested by the USEPA and the ASTM E1739-95 Standard have been integrated into this process.

This process is also consistent with the District of Columbia's overall objective of protecting public health, safety and welfare, the environment, and natural resources for present and future use. The process was developed and is administered by the Department's **Underground Storage Tank Division within the Bureau of Hazardous Material & Toxic Substances**.

Conceptually, the risk-based approach presented in this guidance document could apply to all contaminated sites. However, currently its application is limited to sites contaminated with petroleum products released from UST systems, under the jurisdiction of the Underground Storage Tank Division (Division). For other contaminants or petroleum releases from other sources, please consult with the division.

As the DCRBCA process is implemented, the Division anticipates modifications and/or enhancements due to change in environmental policy and procedure. These modifications and/or amendments will be published as appropriate.

1.2 APPLICABILITY

The intent of the DCRBCA process for USTs is to develop site-specific target levels protective of current and potential future (i) human health, (ii) environment, (iii) nuisance conditions, and (iv) explosive type situations. This guidance focuses on petroleum releases from USTs. However, it can be used for a variety of other chemicals.

It may be appropriate to apply this procedure to petroleum releases from other sources (pipelines, terminals, above ground storage tanks, etc.), if there are no other circumstances at the site that would require application of different risk assessment guidance, e.g. under the RCRA C, D, or CERCLA programs.

This document has been developed for environmental professionals with working knowledge and experience in the areas of site assessment, site investigation, risk assessment, and remedial actions. Technical information is included that describes the DCRBCA program and its elements, including data collection, risk assessment, and corrective action. Since the development of risk-based site-specific target levels is an integral part of the overall process of risk management and has not been described earlier in other guidance documents, it is described at length in this manual (Section 5.0). **<u>However, this guidance document is not intended as a general guide to every aspect of the risk assessment practice</u>.** Prior experience or training will be necessary for an individual to correctly implement risk assessment as part of the overall site management process.

2.1 INTRODUCTION

The DCRBCA process (Figure 2-1) includes a range of site-specific activities that begin with the first notice of a suspected or confirmed release. The process continues until the Division determines that the residual site-specific concentrations are protective of human health and the environment. Upon completion of this process, the Division will issue a **No Further Action (NFA)** letter provided that all the conditions identified in ***Section 6211 of the District of Columbia, Underground Storage Tank Regulations*** have been met.

The DCRBCA process integrates the elements of initial release determination, site characterization, exposure assessment, risk calculations, and risk management activities (including corrective action and risk communication) to determine site-specific chemical concentrations protective of human health and the environment. Each element of the process is important and has to be correctly implemented to ensure adequate protection of human health and the environment.

The DCRBCA process is applicable at all underground storage tank sites irrespective of whether (i) the release has just been detected, (ii) the site is currently under investigation, or (iii) the site is in corrective action. Since the DCRBCA process can begin at any point subsequent to the confirmation of the release, sites currently under assessment should be carefully evaluated to ensure that sufficient quality and quantity of data are available. Sites in the corrective action phase should be evaluated to determine if the target levels proposed in the previously accepted **Corrective Action Plan (CAP)** are appropriate and consistent with the DCRBCA process described in the regulations and explained in this guidance document.

Risk management is an important part of the DCRBCA process. Risk management activities may include active or passive corrective action systems as well as the consideration of owner-imposed institutional controls after the target levels have been established. Institutional controls include but are not limited to land use restrictions, receptor removal or relocation, and communication with potentially affected parties.

As appropriate, based on site conditions, DCRBCA process may use **Remediation by Natural Attenuation (RNA)** as an element of the corrective action process. RNA can be used as the sole corrective action at sites where immediate threats to human health, safety, and the environment do not exist or have been mitigated, and are unlikely to occur. RNA may have to be used in conjunction with other remedial techniques. The case will still be open until the completion of such corrective action process.

2.2 STEP-BY-STEP DESCRIPTION OF THE DCRBCA PROCESS

The DCRBCA process consists of eight steps shown in Figure 2-1 each of which requires performing several activities. Details of the required actions are described in the ***Chapters 55 to 70 of the District of Columbia Underground Storage Tank Regulations.*** Each of the eight steps is briefly described below. The reporting requirements for each step are presented in Table 2-1. Details of the key steps are presented in subsequent sections of this document.

It is important to note that if measurable free product (greater than 0.1 inch thick) is identified anywhere at the site during any of the steps, the responsible party shall take necessary actions to remove the free product to the maximum extent practicable and in a manner that minimizes the spread of contamination.

2.2.1 Step 1: Release Detection

The first step of the DCRBCA process requires the prevention of uncontrolled releases from the existing UST systems, which are in service. To achieve this goal, each UST system must have a method of release detection that complies with the requirements of ***Chapter 60 of District of Columbia's Underground Storage Tank Regulations.*** The release detection system shall be installed, calibrated, operated, and maintained in accordance with the manufacturer's instructions. The record keeping and reporting requirements are discussed in Section 5602 of ***District of Columbia's Underground Storage Tank Regulations.***

2.2.2 Step 2: Release Notification, Abatement, and Reporting

This step of the DCRBCA process requires a responsible party or voluntary responsible party to take immediate action to contain, abate, and cleanup any spill, overfill or release of a regulated substance from a UST. Additionally, the responsible party must provide timely information to the Division related to the release and any abatement actions taken within 24 hours of the occurrence or suspicion of a release. The specific requirements are presented in ***Chapter 62 of District of Columbia's Underground Storage Tank Regulations.*** When a release is suspected, the responsible party shall conduct appropriate tests to confirm the presence or absence of the leak. If the leak is confirmed, the responsible party shall take appropriate steps to repair the leak and initiate appropriate corrective action and notify the Division.

2.2.3 Step 3: Initial Site Assessment

The objective of the initial site assessment is to collect soil and or groundwater samples to either confirm a release or to confirm that a release has not occurred. The responsible party should evaluate the on-site conditions as well as all the information related to the suspected release to select the location and type of samples to be collected. As appropriate the responsible party should comply with any directions provided by the Division. The samples should be located and analyzed in a manner that maximizes the chances of detecting a release if it has occurred. This initial investigation should, at a minimum, be designed to measure the maximum soil and groundwater concentrations at the source i.e. location of spill or release.

The data collected during the initial investigation should be used to determine whether the mandatory cleanup conditions have been met. These include:

1. Removal of the primary leaking source (UST, pipeline etc.),
2. Removal of free product to the maximum extent practicable, typically 0.1 inch in thickness, and
3. Benzene concentrations in groundwater does not exceed 15 mg/L.

If the above conditions have been met, an initial screening level evaluation should be conducted. This evaluation involves the comparison of maximum site concentrations with Tier 0 levels presented in Section 2-3.

2.2.4 Step 4: Site Classification

The objective of this step is to classify the sites into immediate risk, medium risk, short-term risk, long-term risk, and negligible risk sites. This classification system, similar to the classification included in the ASTM RBCA process, is used by the Division to prioritize their workload. This classification system is included in Appendix A.

2.2.5 Step 5: Comprehensive Site Investigation

The objective of this step is to collect adequate quality and quantity of data to perform a site-specific risk evaluation and to develop target levels (Step 6). Specific requirements of a comprehensive site assessment are included in ***Section 6205 of the District of Columbia's Underground Storage Tank Regulations.*** Details of the data that should be collected are presented in Section 4.0 of this guidance document. This step is necessary only if the initial site assessment identifies the need for further action. Prior to performing the comprehensive site assessment, the responsible party should prepare a work plan and get the work plan approved by the Division.

2.2.6 Step 6: Selection or Development of Target Levels

The objective of this step is to select Tier 1 risk based screening levels (RBSLs) from look up tables or develop Tier 2A or 2B site-specific target levels for each complete route of exposure. The identification of the complete routes of exposure will require the development of site conceptual exposure scenarios for current and potential future conditions. Since this is a new step within the DCRBCA process, it is described in detail in Section 5.0 of this guidance document and ***Section 6206 under Risk Based Corrective Action Program of the District of Columbia's Underground Storage Tank Regulations.***

As a part of this step, the target concentrations must be compared with the pathway-specific representative concentrations. If the representative concentrations are exceeded, risk management activities are required at the site, and the process moves to Step 7. However, if the representative concentrations do not exceed the target levels, the responsible party may request a NFA from the Division. In this case the process moves to Step 8.

2.2.7 Step 7: Development and Implementation of the Corrective Action Plan

The objective of this step is to develop and implement an active or passive corrective action plan to achieve the target levels determined in Step 6. The regulatory requirements for the corrective action plan are discussed in ***Section 6207 of the District of Columbia's Underground Storage Tank Regulations.*** Additional discussion is included in Section 6 of this guidance document.

2.2.8 Step 8: Closure Request

After successful completion of the corrective action plan, if necessary, or after the completion of the DCRBCA evaluation (Step 3 or 7), the responsible party may request a no further action letter. Prior to issuing a NFA letter, the Division will evaluate the conditions identified in ***Section 6211 of the District of Columbia's Underground Storage Tank Regulations*** have been met and all monitoring wells have been properly abandoned.

2.3 TARGET LEVELS

To streamline the evaluation of impacted UST sites in the District the responsible party may use any of the following four target levels to achieve case closure:

Tier 0 Screening Levels: As per ***Section 6208 of the District of Columbia's Underground Storage Tank Regulations*** Tier 0 standards are empirical standards that consist of the following;

- Total petroleum hydrocarbons (TPH) gasoline range organics (GRO) or diesel range organics (DRO) shall be no greater than one hundred parts per million (100 ppm);
- Total benzene, toluene, ethylbenzene, and total xylenes (BTEX) shall be no more than ten parts per million (10 ppm); and
- Benzene concentrations shall be no more than one part per million (1 ppm).

For groundwater the Tier 0 standards are the Maximum Contaminant Levels (MCLs). If the maximum site concentrations meet these levels, the responsible party may request case closure.

Tier 1 Risk Based Screening Levels (RBSLs): These are conservative risk based levels developed for a number of different human receptors and two different pathways. The site-specific application of RBSLs will require the development of a site conceptual exposure scenario and the selection of target levels for only those pathways that are complete.

Tier 2A Site Specific Target Levels (Tier 2A SSTLs): These are conservative site-specific target levels that are developed using the same models, equations and input parameters used to develop Tier 1 RBSLs, except for site-specific fate and transport factors. Tier 2A SSTLs have to be established for each complete pathway.

Tier 2B Site Specific Target Levels (Tier 2B SSTLs): These are site-specific target levels that provide flexibility to the responsible party in terms of using any technically defensible approach. To ensure that the approach is acceptable to the division, the responsible party should write a detailed work plan prior to performing a Tier 2B evaluation.

It is important to note that Tier 1, Tier 2A, and Tier 2B risk based levels are based on an acceptable risk level of 1×10^{-6} for carcinogens and a hazard quotient of 1 for non-carcinogens. Thus the responsible party could adopt any of these as the cleanup levels.

2.4 REPORTING REQUIREMENTS

The site-specific implementation of the DCRBCA process requires the responsible party to prepare and submit several reports to the Division. These reporting requirements are tabulated in Table 2-1 and presented below:

Failure of the release detection system report: If the release detection system does not perform according to the manufacturer's requirements, the responsible party must repair the system within 45 days. If the release detection system is not fixed or repaired, the responsible party must report the situation to the Division within 24 hours of the expiration of the 45 days.

Reporting of spills: For spills less than 25 gallons, a responsible party must contain and cleanup the spill within 24 hours. If the cleanup cannot be completed within 24 hours, the responsible party must notify the Division. Spills exceeding 25 gallons, or spills that cause sheen in a surface water body, must be reported to the Division within 24 hours and appropriate corrective action initiated.

Reporting of releases: Any owner, operator, responsible party or their authorized agent must notify the Division of a release or a suspected release within 24 hours. This initiates a 7-day investigation period during which the responsible party must confirm to the Division whether a release has occurred. Additionally, the responsible party must immediately conduct initial abatement and leak detection system tests, if necessary.

An initial site assessment: Within 60 days after confirmation of a release, a responsible party shall submit to the Division an Initial Site Assessment Report and a work plan for future site activities. The contents of the Initial Site Assessment Report are discussed in Section 4.

Free product removal report: Within 45 days of the confirmation of free product at a site and quarterly thereafter, the responsible party must submit a free product removal status report. The period of reporting continues as long as free product persists on the site. Reporting is no longer necessary if free product is not detected for 3 consecutive months.

Comprehensive site assessment report: Within 60 days of the submission of the work plan accompanying the Initial Site Assessment Report, the responsible party shall submit a Comprehensive Site Assessment Report to the Division. The specific contents and activities to be conducted as part of the Comprehensive Site Investigation are discussed in Chapter 4 of this guidance document.

Risk-based evaluation report: Following the completion of the comprehensive site characterization report, the responsible party will perform a tiered evaluation to develop the site-specific target levels and propose a corrective action plan if required. Within 60 days of receipt of the corrective action plan, the Division will either approve or disapprove the plan. Implementation of the plan shall begin within 30 days of receipt of the approval of the Corrective Action Plan. The effectiveness of the plan shall be evaluated at the end of each year.

Groundwater monitoring report: The Division will require the submission of periodic monitoring reports as requested by the Division.

To facilitate the preparation and review of the above deliverables, the District has developed a DCRBCA software that consists of a series of forms that should be completed by responsible party and submitted to the Division. A hard copy of these forms is included in Appendix B. The software can be obtained by contacting the Division.

3.0
RELEASE NOTIFICATION, INITIAL ABATEMENT &CLOSURE REQUIREMENTS

3.1 INTRODUCTION

The DCRBCA process starts when a release or spill is suspected or confirmed at a site. The occurrence or confirmation of a release or spill may be based on either environmental or non-environmental factors. Environmental factors include but are not limited to (i) identification of hydrocarbon vapors or stains in utility trenches, (ii) the occurrence of vapors in basements, or (iii) identification of sheen in water body. Non-environmental factors include but are not limited to (i) shortfall in the inventory, (ii) holes identified in a tank or piping during tank replacement activities, or (iii) failure of a tank test.

The DCRBCA process requires that any person involved in the management, maintenance, or ownership of a UST tank must notify the UST Division of any release or suspected release within 24 hours. Specific release detection record keeping and notification requirements are presented in ***Sections 6001 and 6201 of District of Columbia's Underground Storage Tank Regulations.***

3.2 RELEASE NOTIFICATION

Within the DCRBCA process, a release may be (i) a spill or overfill or (ii) a suspected release.

The notification requirements for a spill are as follows:

- Any spill or overfill must be reported immediately to UST Division and Fire Department if there is any danger of fire or explosion.
- If the volume spilled is less than 25 gallons, the responsible party should take immediate action to contain and cleanup the spill. The UST Division should be notified if the cleanup cannot be completed within 24 hours.
- If the volume spilled is greater than 25 gallons, or if the spill causes a sheen on a surface water body, the UST Division must be informed within 24 hours and corrective action should be initiated.

The UST Division should be notified immediately (within 24 hours) of a suspected release when the following occur:

- Failure of tank tightness test,
- Presence of free product in excavation zone, basement, utility lines, dewatering wells, or a sump,
- Oozing of petroleum product from ground,
- Odors during tanks replacement or construction activities,
- Sudden loss of product from a UST,

- Unusual behavior of dispensing equipment,
- Unexplained presence of water in a tank,
- Results from a release detection method indicate a release,
- Any other situation that may lead someone to suspect a hydrocarbon release.

For each of the above conditions, a written or oral (no voice message) report should be submitted that includes:

- How the release was discovered or suspected,
- The name and telephone number of the release reporter and his/her relationship to the site,
- The site address, contact name, phone number, position and address,
- The name and phone number of the owner operator of the site and any known responsible parties,
- The location, date, time, volume of release, capacity of the tank and the substance released,
- Any initial abatement measures,
- A qualitative evaluation of the human and environmental risks,

Within 7 days of the confirmation of a release, a written report must be submitted to the UST Division, along with the initial report signed by the responsible party. The disposition of any material recovered from the incident should also be included in the report.

3.3 INITIAL ABATEMENT

The primary objective of the initial abatement measures is to take appropriate steps to safeguard human health and the environment and to prevent further release of the hydrocarbons to the environment. Initial abatement may require the following actions:

- Empty the petroleum product from the UST system to prevent any further releases,
- Identify and mitigate any fire, explosion, or vapor hazards by controlling the release or evacuating the area affected by the release,
- Carefully handle any excavated materials or other contaminated media to avoid human contact as well as to avoid contamination of uncontaminated areas,
- Identify the product released,
- Begin removing any free product floating on groundwater or in excavations as soon as possible,
- Initiate any other measures that may help safeguard human health and the environment and prevent further spreading of the hydrocarbons.

Within 20 days after release confirmation, the initial abatement report must be submitted to the UST Division and Fire Chief.

3.4 UST CLOSURE REQUIREMENTS

The reporting requirements for a temporary or permanent closure of a UST system are presented in ***Section 6100 of District of Columbia's Underground Storage Tank Regulations.*** These requirements relate to notification of the Department of Health, permit requirement, safety precautions to be observed during tank removal and closure activities, soil sampling and analysis requirements, disposal of any excavated material, and contents of a tank closure report.

As discussed in Section 6105.15 of District of Columbia's Underground Storage Tank Regulations, depending on the results of the soil and groundwater concentrations, the Director may grant a no further action status or require further site assessment. For the latter, the responsible party should initiate activities to collect the data discussed in Section 4.0.

3.5 FREE PRODUCT REMOVAL

Free product present at a site either as floating on the water table or in the soil represents a potential ongoing source of hydrocarbons that may result in unacceptable risk to human health and the environment. Thus DCRBCA requires the removal of free product to the maximum extent practicable. At a minimum the free product should be removed to prevent any further spreading of the free product or the dissolved constituents into previously uncontaminated areas. The recovered free product should be handled in a manner that will prevent fire or explosion. It is the responsible party's responsibility to identify the most effective method to remove and dispose of the free product.

In forty-five days, after the confirmation of the release, the responsible party should prepare and submit to the Director a status report on the removal of the free product. The report should at a minimum include:

- The name, address, and telephone number of the person responsible for implementing the free product removal measures,
- The estimated quantity, type, thickness of the product observed or measured in wells, boreholes, or excavations,
- The type of free product recovery system,
- The disposition of the free product removed including any permits obtained to discharge the recovered material.

A quarterly status report on the free product recovery system should be submitted until the free product has been removed to the extent practicable.

3.6 MANDATORY CLEANUP CRITERIA (MCC)

The DCRBCA process requires that certain mandatory cleanup criteria be satisfied at a site prior to the development of risk based cleanup levels. These criteria include:

- Removal of the primary source (leaking tank, pipe, saturated soil, etc, if known)
- Removal of free product to the extent practicable, (typically 0.1” thickness is defined as free product),
- Maximum concentration of benzene in groundwater should not exceed 15 mg/l as per ***Section 6210 of the District of Columbia, Underground Storage Tank Regulations***.

The tiered evaluation, described in Chapter 5, should be initiated only if these mandatory cleanup levels have been satisfied at a site. Typically the information gathered during the initial site investigation is used to determine whether the mandatory cleanup criteria have been met as well as to perform a Tier 0 evaluation.

4.0
DATA REQUIREMENTS FOR DCRBCA PROCESS

4.1 INTRODUCTION

This section presents the data necessary to implement the DCRBCA process and a brief discussion of the techniques used to collect the data. This data would typically be collected subsequent to the confirmation of a release as part of the initial and comprehensive site characterization. The specific requirements of the initial and comprehensive site investigation are discussed in ***Sections 6203 to 6305 of the District of Columbia, Underground Storage Tank Regulations***.

The objective of the data collection effort is to ensure that sufficient quality and quantity of data are available to (i) develop a site conceptual exposure model, (ii) compare maximum site concentrations with the Tier 1 screening levels (iii) develop Tier 2A and Tier 2B site-specific target levels, (iv) compare the target levels with representative concentrations, and (v) develop a feasible corrective action plan, if necessary.

To accomplish the above objectives, following categories of data are required:

- Nature and magnitude of the spill or release,
- Site information,
- Adjacent land use and receptor information,
- Vadose zone soil characteristics,
- Saturated zone and groundwater characteristics,
- Distribution of the chemicals of concern in soil,
- Distribution of the chemicals of concern in groundwater, and
- Information about corrective action measures.

The data collected above should be used to complete the DCRBCA report forms (1 through 15). As new data becomes available, these reports should be updated.

At most known leaking UST sites, portions or all of the necessary data may have been collected over an extended period of time, perhaps over several years. As part of the RBCA evaluation, the responsible party must carefully review the available data and identify any data gaps. As appropriate, a work-plan to fill-in the data gaps should be prepared and implemented with the concurrence of the Division. Only after all the necessary data has been collected, the responsible party should proceed with the development of target levels and the preparation of a corrective action plan, if necessary.

As a part of the RBCA evaluation and to understand the soil and groundwater imprints at the site, a comprehensive chronology of events related to site characteristics, remediation, tank removal activity, reported releases etc. must be developed. The chronology of events must be documented using DCRBCA Form 6.

4.2 NATURE AND MAGNITUDE OF THE SPILL OR RELEASE

Knowledge about the nature and magnitude of the spill or release is necessary to identify the soil and/or the groundwater source at the site as well as to identify the chemicals of concern. The following information regarding a spill or release is necessary:

- Location of the spill or release,
- Quantity of the spill or release,
- Product spilled or released, and
- Any interim corrective action measures already performed.

The spill-related information can be obtained by (i) a review of the inventory records, (ii) interview of past employees, (iii) interviews with current on-site workers, and (iv) any spill incident reports filed with the Division.

4.2.1 Location of Spill or Release

Location of spill or release defines the soil and groundwater source area. Likely spill/release locations at petroleum UST sites include (i) corroded or damaged tanks, (ii) piping especially at pipe bends, (iii) joints in pipes, (iv) dispenser islands, and (iv) accidental releases while filling the USTs. A spill or release may occur within the surficial soil (0-1 foot below the ground surface), subsurface soil (1 foot below ground surface to the water table), or below the water table, if the groundwater is shallow (up to 15 feet below ground surface).

The responsible party should review the operational history of the site to determine the location and timing of spill(s) or release(s). For most UST sites, the exact location and timing of the spill/source area may not be known. Moreover, the site may have had multiple spills/releases at different times and at different locations. In these cases, soil and groundwater sampling should be used to identify the likely location and extent (vertical and horizontal) of the residual soil and groundwater source. The exact number and location of samples have to be determined on a case-by-case basis using professional judgement and the concurrence of the Division.

4.2.2 Quantity of Spill or Release

The DCRBCA does not necessarily require knowledge of the exact quantity of the spill or release. Often this information is not known. However, a general idea of the amount released may help evaluate the severity of the site conditions and the extent of contamination. Information on the amount released is typically based on inventory records.

4.2.3 Product Spilled and Chemicals of Concern

Identification of the specific product(s) spilled or released is important to identify the chemicals which are of real concern. The petroleum products regulated by the Division include but are not limited to:

- Gasoline
- Diesel/Light Fuel Oils
- Product Jet Fuel
- Kerosene
- Heating Oil
- Waste/Used Oil

Each of these products is composed of a number of hydrocarbon compounds and additives whose physical and chemical properties and percent composition in the product vary. Further, the environmental behavior (mobility, persistence, and inter-media transport) of the product and the adverse environmental and human health effects depend on (i) the properties of each constituent, and (ii) their concentration in the product.

While evaluating sites impacted by these products, the DCRBCA process focuses on a limited set of chemicals, specific to the product, that pose majority of the risk. These are known as the **chemicals of concern (COCs)**. Table 4-1 lists the major products and the corresponding COCs for which the impacted soil and groundwater should be sampled and for which target levels should be developed.

Table 4-1 also lists the recommended analytical methods for the COCs. These methods should be used unless specific authorization to use alternative methods has been approved by the Division.

If the spill or release at a site can be identified as a single product based on a reported spill or release, free product analysis, or location of impacts (e.g. tank bottom of a particular product tank), COCs for that product only need be analyzed. If the product spilled or released cannot be conclusively identified, COCs corresponding to all the products suspected to have been stored at the site should be analyzed.

If data collected in the past did not include all the suspected COCs at a site, additional sampling may be necessary for the missing COCs before a DCRBCA evaluation can be performed.

4.2.4 Interim Corrective Actions

Typical interim remedial actions include the excavation and off-site disposal of contaminated soil, removal of free product, soil vapor extraction, and pump and treat. Corrective actions performed at the site may have removed all or part of the product spilled or released. Soil and groundwater data collected prior to such activities may not be representative of current conditions and should not be used in risk evaluation. At such sites additional soil and groundwater concentration data should be collected after the completion of the corrective action. Data collected prior to the completion of corrective action, may be used to determine the locations where additional data should be collected.

The nature and magnitude of the spill or release must be reported in DCRBCA Report Form 8.

4.3 SITE INFORMATION

The following site information is necessary to complete the DCRBCA evaluation:

- Site map,
- Ground surface condition,
- Location of utilities on and adjacent to the site,
- On-site groundwater use, and
- Regional hydrogeology and aquifer characteristics.

Relevant site information can be obtained by (i) a site visit, (ii) review of engineering drawings showing the layout of the site, (iii) review of regional information, and (iv) review of files at the Division related to the site or adjacent sites.

4.3.1 Site Map

All maps should be made to scale, with a bar scale, and a north arrow. As appropriate, multiple site maps showing the locations of various structures on-site and the location of monitoring points should be prepared. A detailed site map of the facility showing the layout of the past and current USTs, ASTs, piping, dispenser islands, sumps, paved and unpaved areas, canopy, station building, etc. should be prepared. A second map showing the locations of all (i) on-site monitoring wells including those that may have been abandoned, (ii) water use wells, (iii) soil borings, (iv) any soil vapor extraction wells, and (v) soil excavation areas should be prepared.

Site information must be reported in DCRBCA Report Form 4.

4.3.2 Ground Surface Conditions

Determine whether the site is paved. Also note the type, extent, and general condition of the pavement. Also, determine the slope of the surface.

Ground surface conditions must be reported in DCRBCA Report Form 4.

4.3.3 Location of Utilities On And Adjacent To The Site

Due to the potential for preferential flow of contaminated groundwater and vapors into underground utility lines/conduits, a thorough evaluation of potential and real impacts to underground utilities must be performed. Utilities include phone lines, water lines, sanitary sewers, storm sewers, and natural gas lines. A combination of site observations, knowledge of buried utilities, and discussions with utility representatives and site owner should reveal the locations of site utilities. At a minimum perform the following:

- Locate all underground utility lines and conduits located within the area of known or likely soil and groundwater impact, both on-site and off-site where the release may have migrated, or may migrate in the future.
- Determine the direction of flow in the utilities (water, storm water, and sewage).
- Identify the utility lines/conduits on a base map that also contains a diagram showing the extent and thickness of free product if any and impacts to soil and groundwater.
- Determine depth of the utility lines/conduits relative to the depth of groundwater. Seasonal fluctuations of the groundwater levels should be carefully evaluated. As appropriate, a cross-sectional diagram should be provided illustrating the depth to groundwater and the locations and depths of the lines/conduits.
- Determine the types of materials used for lines/conduits (i.e., PVC, terra-cotta, concrete, steel, etc.).
- Determine any past impacts to utilities and any complaints that may have been previously filed with the Division.
- As appropriate, sample the utilities and vaults using either explosimeters or by taking air samples. If explosive conditions are encountered, immediately inform the Division and the Fire Chief.
- Where a utility is threatened, or where an explosive situation exists, appropriate measures to eliminate fire, explosive, and vapor hazards must be undertaken.
- If free product is present it should be removed to the maximum extent practicable.
- Where dissolved contamination is present, an evaluation of potential impacts of dissolved contamination should be made.

Information about utilities must be reported in DCRBCA Report Form 4.

4.3.4 On-Site Ground Water Use

The current and former owners and operators should be interviewed to determine whether a water use well is/was located on site. In case such a well is identified, construction details of the well should be obtained. At a minimum, the total depth of the well, screen interval, and the use of water should be determined. If such a well is identified and not currently in use or likely to be used in the future, it should be properly abandoned with the approval of the Division. Also any dewatering wells on or adjacent to the facility should be identified.

Groundwater use and well construction details must be reported in DCRBCA Report Form 11.

4.3.5 Regional Hydrogeology and Aquifer Characteristics

Published literature, especially USGS publications, and any investigations conducted on adjacent release sites should be reviewed to determine regional hydrogeology, soil types, and aquifer characteristics. This evaluation should be used to determine type and depth of aquifers in the area and whether they are confined, semi-confined, or unconfined. General aquifer characteristics like yield, Total Dissolved Solids, and salinity of water will help determine the possibility that the aquifer may be used as a potable water source. Regional information will help the responsible party in efficiently collecting site-specific soil and groundwater information as discussed in Section 4.5 and 4.6.

The survey should also locate surface water bodies located within 1000 feet of the site that could be potentially impacted by the site release. If a surface water body is identified, collect information regarding the type (perennial vs. intermittent), water flow rate, flow direction, depth of water, width of the water body, and water use. The water body must be located on an area map.

Hydrogeologic data must be reported in DCRBCA Report Form 10.

4.4 ADJACENT LAND USE AND RECEPTOR INFORMATION

Land use information is used to identify the location and type of receptors, and the complete routes of exposure by which the receptors may be exposed to the chemicals of concern. This information is critical in developing a site conceptual exposure scenario. The following information should be collected:

- Current land use,
- Potential future land use,
- Water well survey, and
- Ecological receptor survey.

Several recent studies (Texas BEG - Mace et al., 1997 and LLNL Study - Rice et al., 1995) have shown that BTEX plumes from UST sites typically extend no more than 500 ft from the source, MTBE plume may extend further. Thus, land use and receptor survey covering a radius of about 1,000 feet from the source is adequate. At sites where there is likelihood that the plume may be much longer, due to the magnitude of the spill or other site-specific conditions, a landuse map covering the entire impacted and potentially impacted area is necessary.

4.4.1 Current Land Use

Land use of the site and its vicinity defines the on-site and off-site receptors who may be exposed to the COCs. There should be no ambiguity about the current land use. A walking land use survey within a 1000 foot radius of the source should be conducted. The survey should clearly identify the following: schools, hospitals, residences (apartments, single-family homes), basements, day care centers, nursing homes, and nature of businesses. The map should also identify surface water bodies, parks, recreational areas, wildlife sanctuaries, wetlands, and agricultural areas. The results of such a survey should be documented on a land use map accurately. It is not necessary to have a map drawn to an exact scale, rather an approximate scale would suffice in most cases.

Land use must be reported in DCRBCA Report Form 5.

4.4.2 Future Land Use

While it is easy to determine the current land use and receptors, future land use and receptors may not be certain. Unless the future land use is known it should be based on local zoning laws and surrounding land use patterns. As appropriate, zone atlas and maps, aerial photographs, local planning offices, the U.S. Bureau of the Census, community master plans, changing land use patterns, interviews with current property owners, and commercial appraisals of a site can provide information for determining land use. Proximity to wetlands, critical habitat, and other environmentally sensitive areas are additional criteria that may help determine future land uses.

It may be appropriate to assume a land use that is conservative from an exposure consideration (i.e. residential) when the future land use cannot be determined. A risk evaluation under a less conservative land use scenario may require a deed restriction.

Land use must be reported in DCRBCA Report Form 5.

4.4.3 Water Well Survey

A water well survey should be conducted to locate all public water supply wells within a mile radius of the site and all water use wells within a half-mile radius. Information sources include the USGS, water system operators, and interviews with local residents. In areas where water use wells are likely a door-to-door survey of businesses and residents may be necessary. The characteristics of the well including age, depth, water use, screen interval, and mode of operation (continuous vs. intermittent) should be documented. Additionally any dewatering wells located within a 1000 ft radius of the site should be identified.

Groundwater use and well construction details must be reported in DCRBCA Report Form 11.

4.4.4 Ecological Receptor Survey

As appropriate, a 1000 foot walking survey around the site to identify any ecological receptors is necessary. Ecological receptors include but are not limited to wetlands, surface water bodies, sensitive habitats or the presence of endangered species. Any site where ecological receptors may be impacted will require consultation with the Division.

Ecological receptor survey results must be reported in DCRBCA Report Form 11.

4.5 VADOSE ZONE SOIL CHARACTERISTICS

The vadose zone soil is the media through which COCs migrate to the groundwater and vapors move upwards to the surface or into an enclosed space. Thus characteristics of the soils have considerable impact on the target levels. Relevant characteristics of soil include:

- Thickness of vadose zone and depth to groundwater,
- Porosity,
- Water content,
- Fractional organic carbon content, and
- Bulk density.

For the development of Tier 1 screening levels, the Division assumed conservative values of these parameters as presented in Table 5-5. For a Tier 2A or Tier 2B evaluation, site-specific values of these parameters, representative of (i) the source area, (ii) soils through which COCs migrate to reach groundwater, and (iii) soils through which vapors of the COCs migrate to reach the surface should be obtained.

Of the parameters mentioned above, organic carbon content must be determined using soil samples not impacted by the release. Since the organic carbon content varies with depth, where ever appropriate, samples representative of vadose and saturated zones should be collected. For measuring porosity and the bulk density of soil an undisturbed sample is necessary. Such a sample can be collected using a Shelby tube. Consideration must be given to collecting multiple samples if multiple lithologies are present which might affect transport of the COCs.

4.5.1 Thickness of Vadose Zone and Depth to Groundwater

The thickness of the vadose zone is determined based on the boring logs. It represents the distance from the ground surface to the depth at which the water table is encountered less the thickness of the capillary fringe.

Depth to groundwater is used in estimating the vapor emissions from groundwater. For outdoor inhalation, an average static depth to groundwater over the area can be used. For indoor inhalation, depth to groundwater below the “floor” of an existing structure of concern or at the most likely location of a future structure should be used.

For sites with considerable seasonal fluctuation in water table level, a yearly average depth for each well may be used. It may be noted that a shallow water table would result in more conservative groundwater target levels protective of inhalation pathways.

4.5.2 Dry Bulk Density (g/cc)

Dry bulk density (ASTM Method D2937-94, Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method) is the dry weight of soil sample divided by the field volume of the soil sample. An accurate measurement of bulk density requires weighing or determining the dry weight and volume of an undisturbed sample. This method involves collecting a core of a known volume, using a thin-walled sampler to minimize disturbance of the soil sample, and transporting the core to the laboratory for analysis.

4.5.3 Porosity (cc/cc-soil)

Porosity is the ratio of the volume of voids to the volume of the soil sample. Many laboratories use dry bulk density and specific gravity data to determine porosity using the following:

$$n = 1 - \rho_b/\rho_s \tag{4-1}$$

where,

n = porosity (cc/cc)
ρ_b = dry bulk density (g/cc)
ρ_s = specific gravity or particle density (g/cc)

The "Standard Test Method for Specific Gravity of Soil" ASTM Method D854, may be used to determine specific gravity. If specific gravity is not available, then 2.65 g/cc can be assumed for most mineral soils. If site-specific values of porosity are not available, it should be estimated from a literature source.

4.5.4 Volumetric Water Content/Moisture Content (cc/cc)

Volumetric water content is the ratio of volume of water to the volume of soil. The ASTM Method D2216-92 (Standard Test Method for Laboratory Determination of Water [Moisture] Content of Soil and Rock) is a gravimetric oven drying method. The water content value used in most models is the volumetric water content. Hence, it may be necessary to use the following:

$$\theta_{wv} = \theta_{wg} * \frac{\rho_b}{\rho_l} \tag{4-2}$$

where,

θ_{wv} = volumetric water content (cc water / cc soil)
θ_{wg} = gravimetric water content, typically reported by the laboratory (g of water / g of soil)
ρ_b = dry bulk density (g of dry soil/cc of soil)
ρ_l = density of water (g/cc)

4.5.5 Fractional Organic Carbon Content in Soil (g-C/g-soil)

Fractional organic carbon content is the weight of organic carbon in the soil divided by the weight of the soil and is expressed either as a ratio or as a percent. The Walkley Black Method (Page and others, 1982. Method of Soil Analysis, Part 2. *Chemical and Microbiological Properties*, pp 570-571, Second Edition) is a chemical oxidation method (rapid dichromatic oxidation) for determining fractional organic carbon content (by ASTM Method 2974) in soil. The results are usually reported as percent organic carbon content. The reported value can be converted to a fraction by dividing by 100.

If the fractional organic matter content is available, it has to be divided by 1.724 to estimate the fractional organic carbon content. Typically fractional organic carbon content is estimated using ASTM Method 2974.

The vadose zone characteristics must be reported in DCRBCA Report Form 10.

4.6 SATURATED ZONE CHARACTERISTICS

COCs that reach the water table typically travel horizontally in the saturated zone. Characteristics of the saturated zone that determine the travel time for the COCs as well as the travel direction include:

- Horizontal hydraulic conductivity,
- Hydraulic gradients (magnitude and direction),
- Saturated zone soil characteristics (fractional organic carbon content, porosity, and Organic carbon content), and
- Indicators of biodegradation.

Of the four characteristics mentioned above, the most important aquifer properties are the horizontal hydraulic conductivity and hydraulic gradient. Each of these are discussed below:

4.6.1 Hydraulic Conductivity (cm/sec)

Hydraulic conductivity is the discharge of water per unit area per unit hydraulic gradient in a subsurface formation. Reliable estimates of site-specific hydraulic conductivity can be obtained by pump tests or slug tests. In the absence of these tests, literature value corresponding to the type of soil in the saturated zone may be used. When a literature value is used, adequate reference and justification for the value chosen should be provided. Hydraulic conductivity may also be estimated based on the grain size distribution of the porous formation.

4.6.2 Hydraulic Gradient

The magnitude and direction of the hydraulic gradient is estimated by comparing water levels measured in the monitoring wells. Typically water level contour maps are prepared based on the measured data using a computer program. These contour maps can be used to estimate both the direction and magnitude of the hydraulic gradient. When drawing the contour maps, care should be taken to ensure that measurements in monitoring wells screened in the same interval or hydrologic unit are used. For sites that have seasonal variation in hydraulic gradient, estimate the average hydraulic gradient for each season.

Consideration should also be given to determining any vertical gradients at the site. Estimate of these will require a comparison of adjacent water levels in wells screened in different intervals.

Saturated zone characteristics must be reported in DCRBCA Report Form 10.

4.6.3 Saturated Zone Soil Characteristics

The saturated zone soil characteristics include the fractional organic carbon content, porosity, and bulk density. These parameters are required to quantify the movement of the chemicals within the saturated zone. The laboratory methods to measure these parameters have been discussed in Section 4.5.

4.6.4 Indicators of Biodegradation

Several indicators (chemical concentrations, geo-chemical indicators, electron acceptors, microorganisms, and carbon dioxide) can be measured at a site to demonstrate the occurrence of natural attenuation. These indicators can be broadly classified into 3 groups: (i) primary, (ii) secondary, and (iii) the tertiary lines of evidence. Data collected under each line of evidence can be evaluated qualitatively or quantitatively to determine the occurrence of biodegradation.

- The primary line of evidence is to demonstrate a reduction in chemical concentration at a site by evaluating measured concentrations within monitoring wells.
- Secondary line of evidence refers to the measurement of geo-chemical indicators that include (i) dissolved oxygen, (ii) dissolved nitrates, (iii) manganese, (iv) ferrous iron, (v) sulfate, and (vi) methane. These indicators should be measured in at least three wells located along the flowline. Locations of these wells include (i) the background or upgradient location, (ii) within the plume near the source, and (iii) within the plume in a downgradient well. Secondary line of evidence is necessary when (i) the primary line of evidence is not conclusive, or (ii) when such information is necessary to design a remedial system e.g. by the addition of oxygen.
- Tertiary line of evidence involves the performance of microbiological studies such as the identification of the microorganisms present in the formation and their cell counts. Tertiary line of evidence is seldom used at petroleum hydrocarbon impacted sites.

The commonly used methods to estimate biodegradation include (i) mass balance analysis for expanding, stable, or shrinking plumes and (ii) plume concentration vs.

distance plots.

Natural attenuation parameters must be reported in DCRBCA Report Form 15.

4.7 DISTRIBUTION OF COCs IN SOIL

Adequate soil concentration data are necessary to (i) compare representative concentrations for each complete pathway to the target levels and (ii) define the soil source dimensions. The assessment should be performed such that the Tier 1 RBSLs are considered throughout the assessment process to define the extent of investigation necessary to assess the horizontal and vertical extent of impacts. If it becomes apparent during the site investigation that the Tier 1 RBSLs will be met, then no additional information may be needed at the site. However, if the concentrations are likely to exceed the Tier 1 RBSLs, the site investigation should be performed such that all data necessary to perform a Tier 2A evaluation are obtained as expeditiously as possible.

The field investigation to collect the soil data should follow the guidance in "***DC Underground Storage Tank Release Investigation and Corrective Action***" Guidance Manual.

The soil investigation(s) should be geared toward collecting the following data/information:

- Identification of the area impacted by COCs appropriate to the type of product released (see Table 4-1).
- Identification of the horizontal and vertical extent of soil impacts. Unless otherwise directed by the Division, the extent of impact should be defined to either non-detect or Tier 1 levels.

DCRBCA evaluation requires that a thorough assessment of source areas be performed to ensure that maximum concentrations of chemicals are detected at the site. To determine the spatial extent of the contamination, soil borings should be drilled starting from the known or suspected source area and drilling outwards until borings with non-detect or Tier 1 screening levels are reached in all directions. To determine the vertical extent of the contamination, soil borings should be extended up to the water table and samples collected from surface and subsurface soil zones as explained in the following sections.

4.7.1 Surficial Soil Sampling

Within the DCRBCA program a distinction is made between surficial soil and subsurface soil. Surficial soil is defined as the soil up to 1 foot below the ground surface.

Evaluation of surficial soil pathways requires representative concentrations in surficial soil. Therefore, adequate number of soil samples should be collected and analyzed for potential COCs from surficial soils. When sampling from boreholes, collect one soil sample for laboratory analysis at a depth of one foot below the surface or 2 inches below the impervious (concrete or asphalt) pavement, whichever is shallower. Note that in some cases, very permeable material may be located 2 inches below the pavement, care should be taken to collect a representative sample.

For sites where the soil assessment *has been completed*:

- Do not take surface soil samples when the site is paved and likely to remain so.
- For sites where the only COCs are volatiles (BTEX) neglect the exposure pathways associated with surficial soil.
- For unpaved sites where the COCs are non-volatile (PAHs or metals), and there is evidence of a surficial spill or a shallow piping leak, collect surficial soil samples.
- For sites where the COCs are non-volatile (PAHs or metals), and there is evidence of a surficial spill or a shallow piping leak, and the site *is* paved, collect surficial soil samples only if the pavement is likely to be removed.

Surficial soil data must be reported in DCRBCA Report Form 12.

4.7.2 Subsurface Soil Sampling

Subsurface soil is the soil below the surficial soil. Since surficial soil extends from the surface to 1 foot below ground surface, subsurface soil extends from greater than 1 foot bgs up to the water table. Most receptors may not have direct exposure to this soil, except for construction worker, who may be involved in excavation activities below the surficial soil zone. Representative concentration in subsurface soil depends on the pathway and therefore, the soil sampling for subsurface soil is pathway-specific as described below:

1. For outdoor inhalation of vapor emissions from subsurface soil, representative concentrations of COCs over the entire soil source area are required.

2. For indoor inhalation of vapors from subsurface soils, for the current scenario, soil samples should be collected from a boring(s) adjacent to the existing structure of concern or, where appropriate, from the most contaminated boring. For the future scenario, these samples should be collected within the footprint of a planned structure or from the most contaminated boring(s).

3. For exposure to a construction or utility worker during excavation activities, representative concentrations in a zone, including the surface and subsurface soils, where construction-related activities are likely to occur, should be estimated.

4. For leaching of COCs in soil into groundwater, the following parameters are critical: (i) thickness of the contaminated soil zone, (ii) distance from the bottom of the contaminated zone to the water table, if any, and (iii) the representative concentration of COCs within the contaminated zone.

Soil sampling must be done in accordance with the following guidelines and procedures:

- Samples must be collected from the source area(s). If the source area(s) has not been identified, soil samples must be collected near the UST system, dispenser islands, and piping.
- Samples must be collected to determine the horizontal and vertical extent of soil contamination. At a minimum, four (4) soil borings must be installed at a site.
- Soil borings must be extended to the water table or to a specified depth (not less than 20 ft bgs) if no water is encountered or depth of impact.
- Samples should be collected at either 2 ft or 5 ft intervals (no more than 5 ft), field screened and at least two samples corresponding to the highest field screening readings should be sent to the laboratory for analysis.
- If the depth to water table is greater than 20-ft bgs, soil below subsurface soil (20 feet bgs) extending up to the water table should be sampled. As with vadose zone soil, samples should be collected at either 2-ft or 5-ft intervals. A sample must always be collected from the capillary fringe and preserved for laboratory analyses. The number of samples (other than the capillary fringe sample) preserved for laboratory analyses can vary depending on the thickness of this zone. The samples should be selected based on Photo Ionization Detector (PID) readings.
- Soil borings should be logged and samples for laboratory evaluation collected in accordance with the methods approved by the Division.
- All samples must be adequately preserved according to the requirements of the laboratory analyses and extracted within the holding times of each particular analysis.
- Sample analyses must be conducted in accordance with current Division analytical requirements and U.S. EPA Office of Solid Waste and Emergency Response SW846 Methods.
- Adequate QA/QC procedures must be utilized to ensure sample quality and integrity. QA/QC of samples should include surrogate and spike recovery and trip blanks whenever possible. The samples must not be cross-contaminated by drilling fluid or by the drilling and sampling procedures. All sampling equipment must be decontaminated utilizing the Division, U.S. EPA, and industry standard protocol.

The appropriate methodology for abandoning boreholes is described in detail in the American Society for Testing and Materials (ASTM) Guidance D 5299-92. The borehole is to be sealed from total depth to the surface with a bentonite/cement grout (6% to 8% bentonite powder). For borings of less than fifty (50) feet total depth, grout placement by tremmie pipe or grout pump should be considered.

Subsurface soil data must be reported in DCRBCA Report Form 13.

4.7.3 Soil Source Data

The soil analytical data, along with the historical use of the site should delineate the soil source area. If more than one source area is identified at a site, each source area should be evaluated separately. Once the soil source(s) is identified, source dimensions can be estimated. Length of source parallel to wind is used to estimate concentrations in ambient air. Since the wind directions fluctuate at any given site, the largest dimension (length instead of width for a rectangular source area) of the source may be used for conservatism. Depth to subsurface soil source should be the depth, in the source area, from surface to the zone where concentrations are above quantitation limits. Professional judgment should be used in choosing the depth, note that a source deeper in soil will result in higher Tier 2 target levels.

4.7.4 Logging of Soil Boreholes

Each soil boring must be logged, by a geologist, to indicate depths correlating with changes in lithology (with lithologic descriptions), soil vapor (e.g. PID) analyses, occurrence of groundwater, total depth, visual and olfactory observations, and any other pertinent data. When a monitoring well is installed, as built diagrams with depth to groundwater must be submitted for each well. A continuous soil profile from at least one boring should be developed with detailed lithologic descriptions. Particular emphasis should be placed on characteristics that control chemical migration and distribution such as zones of higher or lesser permeability, changes in lithology, correlation between soil vapor concentrations and different lithologic zones, obvious areas of soil discoloration, organic content, fractures, and other lithologic characteristics.

All bore logs must be included as an attachment to the DCRBCA Report Form 10.

4.8 DISTRIBUTION OF COCs IN GROUNDWATER

Adequate groundwater samples should be collected to delineate the extent of dissolved contaminant plumes in all directions and to provide representative concentrations based on a site conceptual exposure model. Soil source delineation can serve as a guide in choosing the location of monitoring wells.

4.8.1 Groundwater Sampling

If groundwater has been impacted, temporary sampling points may be used to screen the levels of groundwater impacts and to assist in determining the optimal location of permanent monitoring wells. A sufficient number of monitoring wells should be installed (a minimum of three for a Tier 1 evaluation) to document COC migration and groundwater flow. The monitoring wells must be installed in accordance with the following guidelines and procedures:

- Adequate number of monitoring wells must be installed to sufficiently delineate the horizontal and the vertical extent of the groundwater plume. At a minimum, one monitoring well must be installed in the source, one upgradient, and another downgradient of the source.
- Well placement and design should consider the concentration of COCs in the source area, and the occurrence of NAPLs at the site.
- Wells must be installed in accordance with Division policies and U.S. EPA protocol.

- Well casing and screen materials must be properly selected. The screen interval must be set at least 2-3 feet above the water table.
- Wells must be properly developed and gauged after installation.
- A site survey must be conducted to establish well elevations. Based on the groundwater elevations, groundwater flow direction and gradient should be determined and plotted on a map.

The groundwater samples must be collected in accordance with the following guidelines and procedures:

- Monitoring wells must be purged an adequate number of well volumes prior to collecting a sample, unless the Division accepts data collected using the no-purge or low purge technique.
- Samples must be collected utilizing U.S. EPA approved methods and equipment.
- Samples must be adequately preserved according to the requirements of the laboratory analyses and extracted within the holding times of each particular analysis.
- Sample analyses must be conducted in accordance with current Division analytical requirements and U.S. EPA Office of Solid Waste and Emergency Response SW846 Methods.
- Adequate QA/QC procedures must be utilized to ensure sample quality and integrity. QA/QC of samples should include surrogate and spike recovery and trip blanks whenever possible. All sampling equipment must be decontaminated utilizing the Division, U.S. EPA, and industry standard protocol.

If the plume is not delineated in all directions, location of new monitoring wells should be chosen based the groundwater flow direction and the location of the soil source area.

4.8.2 Groundwater Protection

For potential use of groundwater in the future at a point away (downgradient) from the source, the length, width and thickness of groundwater source will be required. Although the source length and width can be estimated from the groundwater analytical data and soil source dimensions, groundwater source thickness is not measured at the site. A reasonable thickness of 200 cm is usually assumed.

4.8.3 Surface Water and Sediment Sampling

Appropriate samples should be collected when COCs migration is known or suspected to affect a surface water body. Water samples should be collected from both upstream and downstream of a groundwater discharge point. In addition, sediment samples may be collected if the site conditions warrant.

Groundwater data must be summarized in DCRBCA Report Form 14.

5.0
SELECTION AND DEVELOPMENT OF RISK BASED LEVELS

5.1 INTRODUCTION

The DCRBCA process starts when a release is suspected or confirmed at a site and ends when the Division approves a NFA letter or a case closure letter for the site. Thus, the DCRBCA process includes all activities that have to be conducted at the site until the Division determines that the COCs do not pose an unacceptable current or future risk to the public health, safety and welfare, or the environment. As presented in Section 2 of this guidance document, the DCRBCA process consists of eight steps. This chapter discusses Step 6 of the process related to the development of risk-based levels (RBSLs and SSTLs). Figure 5-1 shows the flowchart for this step. Since this step is relatively new and has not been discussed in documents previously published by the Division, it is discussed here in detail.

The DCRBCA process allows calculation of site-specific target cleanup concentrations for soil, groundwater, and air primarily based on the protection of human health due to chronic exposure. These calculations do not take into account non-risk type conditions that may be identified during the investigation, such as excessive odor or staining of soils. Prior to requesting a NFA letter or a case closure letter, the responsible party may be required to mitigate nuisance conditions. The seriousness of the nuisance conditions will be determined as part of site investigation conducted by the responsible party and approved by the Division.

Further, as a part of the site assessment, the responsible party is required to identify and evaluate impacts, if any, to sensitive environmental receptors such as wetlands, surface water bodies, endangered species, etc. The Division, on a case-by-case basis, will identify the specific requirements for evaluating impacts to ecological receptors and any associated corrective action.

5.2 DEVELOPMENT OF SITE CONCEPTUAL EXPOSURE SCENARIO

The development of risk based levels starts with the development of a site conceptual exposure scenario (SCES). A SCES identifies the source of **chemicals of concern** (COC), the COC release mechanisms, the media of concern, the pathways, and the receptors. It presents a working hypothesis of the manner by which COCs migrate from the source or the point of release to the **points of exposure (POEs)** where COCs come in contact with the receptors. If migration of the COCs from the source to the receptors is not possible, or if completion of the pathway is not possible under current or most likely future land use conditions, for example, due to engineering controls, the COCs will not pose any risk. Any pathways that are not complete will not pose any risk. Thus for risk to be present at a site, at least one exposure pathway must be complete. Note for the groundwater pathway, even if there is no ingestion of groundwater and hence no complete pathway, it is still necessary to protect the groundwater resource as discussed in Section 5.4.

A SCES is a qualitative evaluation based on the information collected during site investigations (refer to Section 4.0). Typically, SCESs for three different time periods will be developed for each site: (i) the current land use, (ii) short-term future land use, such as a period of construction, and (iii) long-term future land use. Consideration of current and anticipated future land use ensures that the site-specific decisions will be protective of not only current but also future site use. At sites where the current and future land use are likely to be the same, the current and future SCES would be identical.

A SCES may be presented in a graphical or a tabular format as shown in Figure 5-2 and Table 5-1 respectively. For each complete pathway and route of exposure identified in the SCES, risk based levels must be developed for each COC (see Table 4.1 for a list of the COCs). Key elements of the SCES include (i) land use, (ii) receptors, (iii) pathways, and (iv) routes of exposure. Each of these elements is discussed in the following sections.

The SCES must be documented in DCRBCA Report Form No. 16.

5.2.1 Land Use

Knowledge about the current and anticipated future land use is critical to identify (i) the type of activities occurring on or near the site and (ii) the type of human and ecological receptors.

A determination of current and anticipated future land use must be made for an area currently or likely to be contaminated by site-specific COCs. This determination may include on-site as well as off-site areas.

- **On-site**: Includes the area within the legal boundaries of the property on which the source is/was located. This includes soil, groundwater, surface water, and air within those boundaries.

- **Off-site**: Includes the area outside the legal boundaries of the property on which the source is/was located or impacted from an on-site source. This includes soil, groundwater, surface water, and air located off-site.

Within each area (on-site/off-site) there may be multiple land uses, for example, a plume may have migrated off-site below a residential and a commercial area.

Within the DCRBCA process, land use is categorized as either residential or commercial. Residential land use generally results in lower risk-based levels and cleanup to residential standards will usually allow unrestricted land use. Commercial land use includes industrial uses. Examples of residential and commercial land use are presented below:

- **Residential**: Typically a location where someone is present for an average of more than 8 hours a day. Residential land use includes, but is not limited to, schools, dwellings, residences, parks, playgrounds, hospitals, childcare centers, nursing homes, and any other sensitive human activity areas.

- **Commercial**: Typically a location where someone is on-site less than an average of 8 hours a day. Commercial land use includes, but is not limited to, gas stations, industrial operations, stores, businesses, and fleet operations, where employees work but do not reside on a continuing basis. Hotels, motels, and other transient activities may be included in the commercial definition.

The two categories of land use, commercial or residential, within a 1000-ft radius of the site should be clearly illustrated on maps included with the DCRBCA report. Care should be taken to ensure that the maps represent the current land use and are not reproductions of outdated maps of the area. A discussion of the current and potential future land use is presented in Section 4.4.

5.2.2 Receptors (On-Site and Off-Site)

The objective of DCRBCA process is to make decisions protective of the current as well as the most likely future on-site and off-site receptors. A typical DCRBCA evaluation should consider the human receptors, both children and adults, who live or work within at least 1,000 feet of the site. Additional receptors beyond 1,000 feet should also be identified and their risk evaluated where COC plumes extend or are likely to extend beyond 1,000 feet of the site property boundary.

The human receptors considered in the DCRBCA evaluation include:

Residential – Child	Commercial Worker – Adult
Residential – Adult	Construction Worker – Adult

The primary difference between the construction worker and the commercial worker is the exposure duration. It is anticipated that the above human receptors will be the most exposed. Other human receptors, such as visitors or maintenance workers, will generally have less exposure and, if so, need not be considered further. In the district, for residential conditions, risk based levels for both an adult and a child have to be considered and the lower of the two values used for conservative health risk evaluation.

There are certain sites, such as conservation areas, sensitive resource areas, and agricultural areas, where livestock or wildlife may be potential receptors. In these areas, ecological exposures to wetlands, sensitive environments, or threatened and/or endangered species should be evaluated. Section 5.7 briefly addresses concerns regarding ecological risk evaluations. Sites that have ecological receptors should be evaluated on a case by case basis in consultation with the Division.

Surface water bodies should be evaluated to determine the potential effect of contaminated groundwater or surface water runoff from the site. Estimation of soil and groundwater target levels may be established by accounting for mixing of groundwater discharge with the stream-flow, with the approval of the Division.

On-site and off-site underground utilities must be identified. Environmental concerns related to utilities include: (i) their ability to serve as preferential pathways resulting in vapors in utilities e.g., storm and sanitary sewers, and (ii) potential adverse effects of COCs to property, including degradation of water lines, degradation of sewer lines, damage to outer coatings of gas lines, and damage to buried phone and electrical lines.

Generally acceptable quantitative methods to evaluate adverse effects on utilities are not available; therefore, a qualitative evaluation is appropriate in most cases. Soil vapor surveys along utility corridors or in manholes may be appropriate when quantitative information is essential, as for human exposure issues.

5.2.3 Pathways and Routes of Exposure

A receptor comes in contact with a COC through a completed exposure pathway. For a pathway to be complete there must be (i) a source of COCs, (ii) a mechanism by which the COCs are released, (iii) a medium through which the COCs travels from the point of release to the receptor location, and (iv) a route of exposure by which a COC enters the receptors body and may cause an adverse health effect. This section identifies most commonly encountered exposure pathways at a contaminated site that must be evaluated to determine whether they are complete.

5.2.3.1 Pathways for Inhalation: Intake of COCs can occur by the inhalation of vapors indoors or outdoors. Depending on the toxicity of the COC, unacceptable exposures may occur at concentrations below the odor threshold levels. Situations where indoor inhalation pathways are not complete include (i) no enclosed structures adjacent to or on top of contaminated (media) soil or groundwater, (ii) the structure is protected by a vapor barrier, or (iii) any other factor that makes the indoor inhalation exposure pathway incomplete.

COCs may volatilize from the soil or groundwater and diffuse through the overlying unsaturated zone to indoor or outdoor air where inhalation exposure occurs. To determine if existing soil or groundwater concentrations could generate unacceptably high levels of volatile vapors indoors or outdoors, within the breathing zone, mathematical models are used to calculate risk based soil or groundwater concentrations protective of indoor or outdoor inhalation. The models used by the Division for Tier 1 and Tier 2A evaluations are included in Appendix C. The RBSLs or SSTLs calculated using these models are then compared to the measured soil and groundwater concentrations.

It is important to note that the models used to estimate soil and groundwater risk based levels for this pathway include very conservative (e.g. consideration of an infinite source, absence of any bio-decay of the vapors in the unsaturated zone) assumptions. At sites where the model estimated concentrations are exceeded, it may be useful to measure soil vapor risk based levels. The soil vapor measurements have to be compared with the soil vapor risk based levels. Alternatively the soil vapor risk based levels may be used to estimate the risk.

Concentrations of the COCs may also be measured in the indoor or outdoor air and compared with the relevant RBSLs or SSTLs for indoor and outdoor air, respectively. It is anticipated that COC-specific indoor air measurements will be performed at very few sites due to the technical difficulties associated with accurately measuring the indoor air concentrations contributed by soil or groundwater contamination. Such sites shall be evaluated on a case-by-case basis.

5.2.3.2 Pathways for Surficial Soils (0 - 1 foot): Surficial soils are defined as soils extending from the surface to 1 foot below ground surface (bgs) in unpaved areas. The exposure pathways associated with contaminated surficial soil include:

- Leaching and potential ingestion of contaminated groundwater,
- Leaching and potential migration to a surface water body, and
- Ingestion of soil, outdoor inhalation of vapors and particulates, and dermal contact with soil.

To evaluate these pathways, a sufficient number of surficial soil samples must be collected and analyzed for the COCs from the contaminated area. These sample concentrations are used to estimate the pathway-specific and chemical-specific, representative concentrations that are compared to the RBSLs or SSTLs for the complete pathways for each COC. The estimation of representative concentrations is discussed in Section 5.6.

For the construction worker, surficial soil refers to soil from the surface to the typical depth of construction. Soil within this depth may be brought to the surface during construction activities and result in exposures to the construction worker.

5.2.3.3 Pathways for Subsurface Soils (1 foot bgs to the water table): Subsurface soils are defined as native soils extending from 1-foot bgs to the water table. The exposure pathways associated with subsurface soils include:

- Indoor inhalation of vapor emissions,
- Outdoor inhalation of vapor emissions - typically not a critical pathway and hence it is not necessary to quantitatively evaluate this pathway,
- Leaching to groundwater and potential ingestion of groundwater, and
- Leaching to groundwater and potential migration to a surface water body.

To evaluate these pathways, a sufficient number of subsurface soil samples must be taken in the contaminated area. The sample concentrations are used to estimate the site-specific, representative subsurface soil concentrations for all COCs that are compared to the RBSLs or SSTLs. The estimation of representative concentrations is discussed in Section 5.6.

5.2.3.4 Pathways for Groundwater: Potentially complete exposure pathways for the contaminated groundwater include:

- Indoor inhalation of vapor emissions from groundwater,
- Outdoor inhalation of vapor emissions, typically not a critical pathway and hence do not have to be quantitatively evaluated,
- Ingestion of groundwater, and
- Migration and discharge into a surface water body.

To evaluate these pathways, a sufficient number of groundwater samples must be obtained to adequately delineate the plume. The site-specific representative groundwater concentrations are then compared with the RBSLs or SSTLs. The estimation of representative concentrations is discussed in Section 5.6.

5.2.3.5 Other Pathways: Each of the above exposure pathways must be considered when developing the SCES. In some cases it may be determined that one or more of these routes of exposure are incomplete, such as indoor inhalation of vapor emissions from groundwater if the building is located upgradient of the plume. In such cases the pathway will be eliminated from further consideration.

The professional developing the SCES must evaluate and consider all other pathways and routes of exposure that may be significant at a site, for which the Division has not developed risk based levels. The responsible party should contact the Division for further guidance regarding the evaluation of such pathways and routes of exposure.

5.3 CALCULATION OF RISK BASED LEVELS

This section presents the development of target levels and the default data used to develop Tier 1 screening levels. Appendix D presents a discussion on the development of target levels for TPH groups.

5.3.1 Target Risk Level

As per the District's regulations, a risk-based decision making process requires the specification of a target risk level for both carcinogenic and non-carcinogenic adverse health effects. The target risk levels are used to estimate the target exposure point concentrations. For carcinogenic effects, the Division will use an **individual excess lifetime cancer risk (IELCR)** of 1×10^{-6} as the target risk for both current and future receptors. For non-carcinogenic effects, the acceptable level is a hazard quotient of one (1) for current and future receptors. These target risk levels are used for all tiers.

The estimation of cumulative risk or the hazard index (sum of hazard quotients) is not required for the following reasons:

- There are a limited number of COCs at most regulated underground storage tank release sites and the COC's affect different organs,

- The DCRBCA process uses conservative exposure factors and target risk values, and
- The models used to estimate the RBSLs and SSTLs include numerous conservative assumptions.

Thus, the risk and hazard quotient from multiple COCs and multiple routes of exposure will not be added except for the routes of exposure associated with the surficial soil. The surficial soil risk based levels are based on the cumulative effect of ingestion, inhalation, and dermal contact with a chemical.

5.3.2 Chemical-Specific Physical and Chemical Properties

The development of risk based levels, requires selected physical and chemical properties of the COCs. The values of these parameters are listed in Table 5-2. Several of these values are experimentally determined. Thus their values in different references may differ. The Division requires the use of values tabulated in Table 5-2 for all DCRBCA evaluations unless there are justifiable reasons to modify these values. If such reasons exist, the responsible party must provide sufficient justification to the Division to utilize a different value before performing the evaluation. The Division may update the data in Table 5-2 if new information becomes available.

5.3.3 Quantitative Toxicity Factors

The toxicity of chemicals is quantified using slope factors (or potency value) for chemicals with carcinogenic adverse health effects. For chemicals that cause non-carcinogenic adverse health effects, toxicity is typically quantified by reference dose or reference concentrations.

Toxicity values for the COCs are presented in Table 5-3. The Division requires that the most recent toxicity values recommended by the U.S.EPA be used for the evaluations. As of the publication of this document, the values listed in Table 5-3 represent the most recent values and should be used for both Tier 1and Tier 2A evaluations.

The availability of a more current, technically defensible toxicity value would be a justifiable reason to use an alternative value.

To check the current toxicity values for COCs, the following sources may be contacted in the order listed:

i. The Division,
ii. USEPA's Integrated Risk Information System (IRIS),
iii. Health Effects Assessment Summary Tables (HEAST), periodically published by the USEPA,
iv. Agency for Toxic Substance and Disease Registry (ATSDR),
v. Direct communication with the appropriate USEPA personnel, and
vi. Review of literature by qualified professionals to develop toxicity factors.

5.3.4 Exposure Factors

Exposure factors describe the physiological and behavioral characteristics of the receptor. These include factors such as the body weight, body surface area, air inhalation rates, water ingestion rate, etc. A list of default exposure factors to be used for Tier 1 and Tier 2A evaluations are presented in Table 5-4. The exposure factors are typically estimated based on literature and site-specific measurements are not conducted. For a Tier 2B evaluation, site-specific values of the exposure factors, other than default values, may be used if they can be justified. An excellent source of information is the USEPA's *Exposure Factors Handbook Volume I - General Factors* (August 1997).

> ***Justification for the Tier 2A exposure parameters if different from Tier 1 values should be included in DCRBCA Report Form 26.***

5.3.5 Fate and Transport Parameters

Fate and transport parameters are necessary to estimate the target levels for the indirect routes of exposure. These factors characterize the soil, groundwater, ambient air, and typical enclosed space. For a Tier 1 evaluation, the Division has selected generic conservative default values that are listed in Table 5-5. For Tier 2A and 2B evaluation a combination of site-specific and generic values for these parameters may be used. However, the value of each parameter used must be justified based on site-specific conditions. A brief discussion of some of these parameters is presented below:

> ***Justification for the Tier 2A fate and transport values must be provided in DCRBCA Report Form 24.***

5.3.5.1 Indoor and Outdoor Inhalation: The fate and transport models used to estimate volatile emissions from soil and groundwater require information about the soils in the vadose zone. The specific parameters required include:

- Soil bulk density,
- Organic carbon content,
- Porosity,
- Water content, and
- Air content.

The method used to measure these parameters is discussed in Section 4.5. It is important to note that the sum of the water content and the air content must equal porosity.

Several other parameters are required to estimate the target levels for indoor and outdoor inhalation. These include:

- Air exchange rate in the building that depends on the construction of the building. Default values, listed in Table 5-5, may be used for Tier 2A as well as Tier 2B evaluation. Literature values may be obtained by researching architectural and building design publications.

- Height of the enclosed space is typically equal to the height of the first floor of the building,
- Areal fraction of cracks in the foundation of the building,
- Wind speed in the breathing zone,
- Height of the outdoor breathing space, typically estimated as 200 cm,
- Length of soil source parallel to the wind direction. This parameter is estimated based on the area of the contaminated soil identified during site characterization,
- Depth to COCs in subsurface soil, and
- Depth to groundwater.

5.3.5.2 Protection of Groundwater: Several fate and transport parameters are required to estimate (i) the soil source concentration protective of the groundwater, (ii) the target compliance well(s) concentration, and (iii) source well(s) concentrations. These include:

- **The areal dimensions of the soil source**: including the length and width of the soil source, as shown in Figure 5-3. These dimensions are estimated based on the site characterization data and should represent the most contaminated portion of the site. At sites where there are multiple sources, it may be appropriate to define more than one soil source. In the DCRBCA process, it is conservatively assumed that the COCs travel vertically downwards to the water table without any lateral dispersion. Therefore, the areal dimensions of the groundwater source are the same as the dimensions of the soil source. For Tier 1 evaluation, the thickness of the groundwater source is assumed to be 305 cm. Analytical equations to estimate the thickness are available in Salhotra et al (1990) and the U.S.EPA (1996).

- **Soil properties representative of the soil source** including organic carbon content, porosity, water content, and air content. The soil properties in the soil source zone may differ from those of the vadose zone. For calculating Tier 1 RBSLs, it was assumed that values representative of the vadose zone are also representative of the soil source zone.

- **Soil properties representative of the saturated zone** including organic carbon content, hydraulic conductivity, and hydraulic gradient. For Tier 1 evaluation (calculation of RBSLs), the organic carbon contents of the vadose zone and the saturated zone were assumed identical.

- **Infiltration rate through the soil source.** For Tier 1 evaluation the infiltration rate may be assumed equal to 10% of the annual rainfall. In the absence of site-specific infiltration rate, this value may also be used for Tier 2A evaluation.

The evaluation of the groundwater protection pathway requires additional parameters that are included in Table 5-5. These parameters include distances to the POE and the **point of compliance (POC)** and have been discussed in Sections 5.4.1 and 5.4.2 of this guidance document.

5.3.6 Mathematical Models

Two types of models or equations, namely (i) the uptake equations, and (ii) the fate and transport models are required to calculate the risk based levels. For Tier 1 and Tier 2A evaluations, the Division has selected the models and equations presented in Appendix C. These models have been programmed in the DCRBCA Computational Software and were used to develop the Tier 1 RBSLs presented in Section 5.9. For Tier 2A evaluations, the Division recommends the use of these equations and models. For Tier 2B evaluations if the responsible party intends to use alternative models, their application must be pre-approved by the Division. A guide to selection of an appropriate fate and transport model is ***ASTM (1999) RBCA Fate and Transport Models: Compendium and Selection Guide or USEPA 625/6-90/016a; Groundwater Volume I; Groundwater and Contamination***.

5.4 PROTECTION OF GROUNDWATER

The RBCA process requires the protection or remediation of groundwater to the groundwater standards listed in Table 5-6. The responsible party can demonstrate that these standards are being met by comparing the representative concentrations in the exposure and compliance wells with these levels. The location of the POE and POC wells is discussed below:

5.4.1 Location of Exposure Wells

The groundwater ingestion POE will be established at the nearest point where a water use well currently exists, or is most likely to exist in the foreseeable future. If no such wells exist or are unlikely to be installed, then the POE, for Tier 1 evaluation, will be located at the closest down-gradient private property boundary. For Tier 2A evaluation, the POE may be located at a distance lesser of 500 feet from the property boundary or 1,000 feet from the contamination source. The Division has developed this guidance for the location of the POEs based on consideration of the current and potential future shallow groundwater use in the DC area. The responsible party should be able to demonstrate that (i) groundwater between the source and the POE is not likely to be used in the foreseeable future and (ii) the plume is stable prior to receiving a no further action determination

At sites where the flow is radial or the flow direction fluctuates, multiple POEs, one in each flow direction, may have to be established.

5.4.2 Location of Compliance Wells

The responsible party and the Division will identify one or more wells as POCs. At most sites, existing monitoring wells would be used as POCs. Wells used as POCs are also called **Compliance Wells** (**CWs**). These are wells located between the source and the POE where the groundwater concentrations will be measured to confirm that (i) the concentrations at the POE will not exceed the target levels, and (ii) the plume is stable or decreasing in size and concentration. Figure 5-4 shows a schematic of the source, compliance wells, and the exposure well or POE. Note that multiple compliance wells may be associated with a source and a POE.

5.4.3 Calculation of Soil Concentration Protective of Groundwater

This section presents the methodology used to develop soil concentrations protective of groundwater for Tier 1 evaluation. The same methodology should be used for a Tier 2A evaluation by replacing the conservative default assumptions with site-specific fate and transport parameters to the extent possible. At a minimum, site-specific values of the soil source dimensions, organic carbon content, porosity, water content, soil bulk density, hydraulic conductivity, hydraulic gradient, and distances to the POE and CWs should be used.

Figure 5-4 shows a schematic of the leaching of COCs from the soil source to the POE and CWs. As the leachate migrates from the soil source to the point of exposure, its concentration decreases in three zones:

- in the unsaturated zone, due to natural attenuation processes occurring between the point of release and the groundwater table (represented by an unsaturated zone **dilution attenuation factor** DAF_{unsat}),
- at the groundwater table due to mixing with the regional, uncontaminated groundwater flow (represented by a mixing zone DAF_{mix}), and
- in the saturated zone, due to natural attenuation processes occurring between the mixing zone and the point of exposure (represented by a saturated zone DAF_{sat}).

Based on the process described above, soil concentration protective of groundwater can be calculated using the following equation;

$$C_{soil} = DAF_{unsat} \text{ x } DAF_{mix} \text{ x } DAF_{sat} \text{ x } C_{POE} \text{ x } ECF \qquad (5\text{-}1)$$

In the above equation, the equilibrium conversion factor (ECF) converts the leachate concentration to soil concentration.

In the above equation, the DAFs represent the reduction in concentration as the COC travels from (i) the soil source to the water table (DAF_{unsat}), (ii) mixes with the required groundwater (DAF_{mix}), and (iii) from the groundwater source to the POE (DAF_{sat}). This reduction in concentration is a result of the combined effect of several physical, chemical, and biological factors including advection, diffusion, dispersion, dilution, adsorption, and biodegradation processes. In general, there are two ways to estimate the DAFs: (i) using a fate and transport model, or (ii) by calculating the ratio of the measured concentration at the source well and the POE. The second method can be used only at sites where the plume is stable or decreasing in size and concentration and sufficient groundwater monitoring data are available.

For the development of Tier 1 RBSLs, the DAF_{unsat} was assumed to be unity i.e., attenuation within the unsaturated zone was neglected. This is reasonable and conservative due to the relatively shallow depth to contamination at most UST sites in the District. The Summer's model was used to estimate the DAF_{mix}. The Domenico's model was used to estimate the DAF_{sat}. The specific equations for each of the DAFs are presented in Appendix C.

The default input parameters for the Summer's, and Domenico's models are presented in Table 5-5.

A step-by-step procedure to develop compliance well target levels is presented below:

5.4.3.1 Step 1 - Identify POE(s): Refer to Section 5.4.1 for guidelines to select POE(s).

5.4.3.2 Step 2 - Establish Target Levels for the POE: The groundwater quality standards that have to be met at the POE are discussed in Section 5.4 and presented in Table 5-6.

5.4.3.3 Step 3 - Identify Compliance Wells: Refer to Section 5.4.2 for guidelines to select CWs.

5.4.3.4 Step 4 - Establish Compliance Well Target Levels: Because the CWs are located between the source and the POE, the target CW concentrations would be higher than the target exposure point concentration. The difference reflects the reduction in concentration of the COCs as they migrates from the CW to the POE.

For a Tier 1 evaluation, Table 5-7 lists the DAFs that should be used to estimate the CW target concentration. These DAF's conservatively assume that the COC's do not degrade. For Tier 2B evaluations, DAFs may be calculated using site-specific monitoring data or an alternative fate and transport model implemented using site-specific data.

Specifically, the target concentration at the CW is estimated using:

$$C_{target}^{CW} = C_{target}^{POE} \frac{DAF_{POE}}{DAF_{CW}} \qquad (5\text{-}2)$$

where,

C_{target}^{CW}	=	Target concentration in the CW [mg/L]
C_{target}^{POE}	=	Target concentration at the POE (groundwater standard) [mg/L]
DAF_{POE}	=	Dilution attenuation factor between the POE and the source [(mg/L)/(mg/L)]

DAF_{CW} = Dilution attenuation factor between the CW and the source [(mg/L)/(mg/L)]

5.5 PROTECTION OF SURFACE WATER

The DCRBCA process requires the protection of surface water to the standards listed in Table 5-6. For a Tier 1 evaluation, the surface water target levels have to be met at the location where the groundwater plume seeps into the surface water body. For Tier 2A and 2B evaluations, dilution due to the mixing of the groundwater plume with the surface water may be allowed by the Division, on a case-by-case basis. Thus, in this case, the surface water standards of Table 5-6 would be applicable at the downstream edge of the mixing zone.

The procedure presented in Section 5.4.3 can be used to develop compliance well target concentrations for the protection of surface waters. The POE will be established at the nearest downgradient surface water body (Tier 1) or the edge of the mixing zone within the stream (Tier 2A and 2B). At sites where the compliance well concentrations are exceeded, the Division will require active or passive remediation until the concentrations stabilize below the calculated target levels.

5.6 ESTIMATION OF REPRESENTATIVE CONCENTRATIONS FOR SOIL AND GROUNDWATER PATHWAYS

A key aspect of the DCRBCA process is the calculation of representative concentration for each COC, in each medium, and for each pathway. The representative concentrations are compared with the relevant RBSLs (in Tier 1) and SSTLs (in Tier 2A and 2B) to make site-specific decisions. **Thus, the outcome of the risk management decision critically depends on the definition of the representative concentration**. The representative concentration as defined below will always be less than or at most equal to the maximum concentration. Thus if the maximum soil and groundwater concentrations do not exceed the risk based levels, it is not necessary to calculate the representative concentrations. In no case should the maximum concentration exceed the representative concentration by a factor of 10.

5.6.1 Representative Groundwater Concentrations

For this pathway, at least three target concentrations are relevant: (i) concentration at the POE, (ii) concentration at the compliance well(s), and (iii) soil source concentration. Thus at least three representative concentrations are required for this pathway. The representative concentration in the POE well and the CW can be estimated as the average of the recent 2 years of data from each well unless the concentrations in these wells show an increasing trend. If the wells show an increasing trend, the most recent concentration must be used. Note that the Division will not issue a NFA or a case closure letter until concentrations in these and any other site related wells show a decreasing or stable concentration.

To estimate the representative soil source concentration for the groundwater pathway, it is first necessary to identify the soil source zone on a site map. The representative soil source concentration is the average of soil concentrations measured within the source zone. Concentrations reported as below detection limit within the source zone may be replaced by half the detection limit.

For the indoor inhalation pathway, the representative concentration in groundwater is the average concentration from wells adjacent to an existing building or within the potential footprint of a future building can be used. If there are multiple wells, the recent two year average concentration in each well is first estimated as the representative well concentration. These well concentrations are then averaged across the wells adjacent to the building to calculate the representative concentration. This process accounts for both temporal and spatial variation in the data.

5.6.2 Representative Soil Concentrations (For Surface Releases)

The following steps are necessary to evaluate the representative soil concentrations:

Step 1: Evaluate whether the spatial resolution of the data is sufficient. Whereas the exact number of samples cannot be specified, samples should be collected and data should be available from the areas of known or likely sources. Also, both surficial and subsurface soil data are necessary.

Step 2: If the data are old and not representative of current site conditions, (e.g. if a new spill is suspected or site remediation has occurred since the data was collected), the Division may require the collection of current data. However if the available data are old but below RBSLs or SSTLs and no release is suspected since the data were collected, it may not be necessary to collect new data. If sufficient new data are collected, they may be used for risk evaluation and the old data may be disregarded. In all cases, a new release will require the collection of additional data.

Step 3: After it has been determined that sufficient data are available to define the horizontal and vertical extent, magnitude, and character of COCs, the representative concentration should be calculated by using the arithmetic mean (straight average). While calculating these concentrations, note the following:

(a) Non-detect soil samples located **at the periphery of the impacted area** should not be used. The impacted area is defined by visual or olfactory evidence of contamination and/or by laboratory data above detection limits.

(b) Non-detect samples **within the impacted area** are considered contaminated to half the applicable detection limit.

(c) **Hotspots** and discrete areas of contamination may require additional evaluation. A hotspot is an area where the maximum concentration is greater than ten times the average concentration.

5.6.3 Representative Soil Concentrations (For Subsurface Releases)

A representative concentration should always be tied to the route of exposure and the exposure domain, which is the area over which exposure can occur. The following steps are necessary to determine the representative soil concentration for a subsurface release:

Step 1: Evaluate whether sufficient laboratory data is available to fully define the horizontal and vertical extent, magnitude, and character of soil contamination for each area of release.

Step 2: If the data are old or otherwise not representative of current site conditions, a new spill is suspected since the data were collected, or site remediation has occurred since samples were collected, the Division may require the collection of additional data. If sufficient new data are collected, they may be used for risk evaluation and the old data may be disregarded. A new release will require the collection of additional data.

Step 3: After it has been determined that sufficient data are available, the representative concentration should be calculated by averaging all laboratory analyses obtained from samples within the exposure domain. As mentioned earlier, the exposure domain is the area over which exposure can occur. While calculating these concentrations, note the following:

(a) Non-detect soil samples **within the exposure domain** are considered contaminated to half the applicable detection limit.

(b) Laboratory results from soil borings **peripheral to the exposure domain** should not be used.

(c) Hotspots and discrete areas of contamination may require additional evaluation.

5.6.4 Representative Soil Concentrations (for Subsurface Releases, Indoor Inhalation Pathway)

For calculating a representative site concentration in soil for comparison to the target concentration for the indoor inhalation pathway, follow the procedures as described in Section 5.6.3 and obtain the average concentration from subsurface samples collected adjacent to an existing building or within the potential footprint of a future building.

5.7 ECOLOGICAL EXPOSURE

An ecological risk evaluation should be performed for sites on or adjacent to wetlands, sensitive environments, or habitat for threatened or endangered species. Where an ecological threat may exist due to a release, an ecological evaluation must be performed. The responsible party should follow the Division guidelines for this evaluation.

5.8 DOCUMENTATION OF THE DCRBCA EVALUATION

As a part of the development of the DCRBCA process, the Division, working with The Partners in RBCA Implementation, has sponsored the development of software packages: (i) DCRBCA report forms, and (ii) a computational spreadsheet to perform Tier 2A calculations.

The Division requires that all Tier 2A evaluations use these DCRBCA report forms (Appendix B), however, this does not preclude an evaluator from using other appropriate computational tools. This software may be obtained by contacting the developers of the software, Risk Assessment & Management Group, Inc. at (713) 784-5151 at SMATUL@AOL.com.

If an evaluator chooses to use an alternate computational tool, the Division will require determination of the applicability of the computational tool as well as a verification of the results.

5.9 TIER 1 EVALUATION

Tier 1 evaluation requires the comparison of site-specific representative soil and groundwater concentrations with the Tier 1 RBSLs established by the Division for the complete routes of exposure. Before performing a Tier 1 evaluation, the responsible party must satisfy the mandatory cleanup criteria identified in Section 3.6.

A Tier 1 evaluation requires the following steps:

Step 1: Development of Site Conceptual Exposure Scenario

Step 2: Selection of relevant Tier 1 risk based screening levels (RBSLs)

Step 3: Comparison of RBSLs selected in Step 2 with representative site-specific concentrations

Step 4: Selection of the next course of action

Each of these steps is discussed below:

5.9.1 Step 1: Development of a Site Conceptual Exposure Scenario

The development of a SCES has been described in Section 5.2. This step includes the location of the point of exposure (POE) for each complete route of exposure.

5.9.2 Step 2: Selection of Relevant Tier 1 Risk Based Screening Levels (RBSLs)

For each complete exposure pathway identified in Step 1, RBSLs should be selected for each COC and TPH group (TPH-GRO, TPH-DRO, and TPH-ORO) from the appropriate Tier 1 table. The Division has developed RBSLs for commonly encountered routes of exposure and receptors as discussed in Section 5.3. The RBSLs for the various receptors and routes of exposure are presented in Tables 5-8 through 5-11.

To select the appropriate Tier 1 RBSLs protective of groundwater from Table 5-12, the locations of the nearest POE and POC have to be determined as described in Section 5.4.1 and 5.4.2.

5.9.3 Step 3: Comparison of RBSLs Selected in Step 2 with Representative Site-Specific Concentrations

After the Tier 1 RBSLs have been identified, they are compared with the representative concentrations to identify the next course of action presented in Section 5.9.4. The representative concentrations should be determined as discussed in Section 5.6.

5.9.4 Step 4: Selection of the Next Course of Action

Comparison of Tier 1 RBSLs with the representative concentrations will result in one of the following situations:

If the representative concentrations do not exceed the RBSLs and the site satisfies the requirements of ***Section 6211 of the District of Columbia, Underground Storage Tank Regulations***, the Division may approve NFA status.

These requirements include but are not limited to:

- The site does not and is not likely to pose a threat to human health or the environment as demonstrated by a comparison of the RBSLs with the site concentrations,
- No nuisance conditions exist at the site,
- Free product has been removed to the extent practicable, and
- As applicable, the CAP approved remedial plans have been met.

If the site concentrations exceed the Tier 1 values, the following three risk management alternatives are available.

Alternative 1: Remediation of Localized Exceedences. If site concentrations exceed the Tier 1 RBSLs in a discrete, limited portion of the site, the responsible party, with the Division's approval, may choose to conduct interim remediation to meet Tier 1 levels. An example of this scenario is the presence of a small quantity of soil that exceeds the Tier 1 levels. Removal or treatment of this small area of soil may be sufficient to allow the site to meet the Tier 1 Levels and achieve NFA status without preparing a full fledged corrective action plan. Another example is excavation for complying with approved remedial plans to meet Tier 1 RBSLs for real property transactions. This action is different from an initial response action in that the latter focuses on the abatement of potential or real emergency conditions.

Alternative 2: Selection of Tier 2A Evaluation. The responsible party may conduct a Tier 2A evaluation that may require the acquisition of additional site data.

Alternative 3: Remediation to Tier 1 Levels. With department approval, the responsible party may elect to develop a remediation plan to remediate the site to Tier 1 levels. Under this alternative the RBSLs become the cleanup levels. The plan would have to meet the requirements approved and supervised by the Division.

The responsible party should review the site conditions and propose one of the three alternatives listed above. The selection of Alternative 1, 2 or 3 will most likely be based on technical feasibility and economic considerations. For example, where the cost of cleanup is low (relative to the cost of additional data collection and analysis under a Tier 2 evaluation), it may be cost-effective to adopt the Tier 1 RBSLs as the cleanup levels.

5.10 TIER 2A EVALUATION

This section provides guidance for a Tier 2A evaluation that will be conducted when Tier 1 RBSLs are exceeded and it is not appropriate to adopt those three alternatives, to remediate the site to Tier 1 RBSLs. The Tier 2A evaluation is very similar to the Tier 1 evaluation in that it (i) is conservative; (ii) is broadly defined by the Division but allows for some flexibility; (iii) uses relatively simple fate and transport algorithms (models); and (iv) uses default exposure factors.

The Tier 2A evaluation requires the following steps:

- Step 1 Development of site conceptual exposure scenario,
- Step 2 Selection of input parameters,
- Step 3 Calculation of Tier 2A SSTLs,
- Step 4 Comparison of SSTLs calculated in Step 3 with representative site-specific concentrations, and
- Step 5 Selection of the next course of action.

5.10.1 Step 1: Development of a Site Conceptual Exposure Scenario

The responsible party should develop the SCES if it has not already been developed and identify the complete exposure routes and pathways. In most cases, the SCES for Tier 2A evaluation would be the same as the SCES developed for a Tier 1 evaluation. Tier 2A target level should be calculated for all COCs and all complete pathways and routes of exposure even if the representative concentrations did not exceed the Tier 1 RBSLs.

5.10.2 Step 2: Input Parameters

Typically for a Tier 2A evaluation, the same models and algorithms used to develop the Tier 1 RBSLs, will be used. Thus, the Tier 2A input parameter requirements will be the same as for Tier 1. The specific values to be used for these parameters are discussed below. The Division intends to regularly review and update the referenced tables to reflect the most current information for all four categories of parameters.

Exposure Factors: The Division requires that the default Tier 1 exposure factors (Table 5-4) be used unless the responsible party can justify alternative values based on site-specific considerations.

Physical and Chemical Properties: The Division requires the physical and chemical properties used for Tier 1 evaluation (Table 5-2) be used unless the responsible party can justify alternative values.

Toxicity Values: The Division requires that the current toxicity values promulgated by USEPA be used. These are same as the values used for Tier 1 evaluation, listed in Table 5-3.

Fate and Transport Parameters: The Division allows the owner and operator to use a combination of default and representative site-specific fate and transport parameters for a Tier 2A evaluation. The parameters identified with two asterisks in Table 5-5 must be replaced by site-specific values. Where site-specific values are not available, professional judgment has to be used to determine whether to collect additional data, use estimates from adjacent sites, literature values, or Tier 1default values. If additional data is necessary, a data acquisition workplan should be developed and approved by the Division prior to performing the Tier 2A evaluation.

For the Tier 2A evaluation, the Division will allow the use of chemical-specific biological decay rates based on literature values but prefers the use of site-specific evaluation of historic monitoring well data to estimate a site-specific biodecay rate. A biodecay rate will be allowed only when the groundwater concentration data indicate a clear decreasing trend or the site-specific natural attenuation parameters indicate the occurrence of biodecay. In cases where literature values are used, the half-life for any COC must not be less than 5 years, i.e., the first order decay rate should not exceed (ln 0.5)/5 = 0.139 yr^{-1}. Note the DAFs presented in Table 5-7 were estimated assuming no bio-decay.

The Target Risk: The target risk for all tiers is the same, in accordance with ***Section 6206.4(c) of the District of Columbia, Underground Storage Tank Regulations***. A discussion of the target risk levels is presented in Section 5.3.1 of this guidance.

5.10.3 Step 3: Calculation of Tier 2A Levels

The calculation of Tier 2A SSTLs should be performed by using the models and equations presented in Appendix C and the input parameter values discussed above. For computational ease, the Division has sponsored the development of a software, which may be used for the calculations. Also refer to Section 5.8.

The Division is not disallowing the use of other appropriate computational tools, but it requires that the Division approve models and input parameters before they are used. If a RBCA evaluator uses alternative tools, the Division may require verification, including submission of a copy of the software.

5.10.4 Step 4: Comparison of SSTLs Calculated with Representative Site-Specific Concentrations

The representative soil and groundwater concentrations for each complete route of exposure are calculated as for Tier 1 evaluation. See Section 5.6 for the calculation of representative concentrations. These representative concentrations are then compared with the Tier 2A SSTLs.

5.10.5 Step 5: Selection of the Next Course of Action

After the completion of a Tier 2A evaluation, the Division may approve NFA letter or case closure determination if the site concentrations satisfy the requirements of ***Section 6211 of the District of Columbia, Underground Storage Tank Regulations***. These requirements include, but are not limited to:

- The representative site concentrations do not exceed the Tier 2A levels and the maximum concentration in each medium does not exceed the representative concentration by a factor of 10,
- No nuisance conditions exist at the site,
- Free product has been removed to the extent practicable, and
- The Division agrees with the Tier 2A evaluation and determines that additional confirmatory or compliance point monitoring is not necessary,
- As applicable, the approved remedial plans have been met.

If any representative site concentration exceeds the Tier 2A SSTLs for any COC, the following three alternatives are available.

Alternative 1: Remediation of localized exceedences to Tier 2A Levels. This alternative applies when there is a localized exceedence of Tier 2A SSTLs. With the department's concurrence, the responsible party may select to perform interim remediation measures to achieve the Tier 2A levels without writing a complete corrective action plan which would be necessary if alternative 3 were selected.

Alternative 2: Selection of Tier 2B Evaluation. The responsible party may conduct a Tier 2B evaluation that may require the acquisition of additional site data.

Alternative 3: Remediation to Tier 2A SSTLs. With department approval, the responsible party may elect to develop a remediation plan to remediate the site to Tier 2A SSTLs. The plan would have to meet the requirements of ***Section 6207 of the District of Columbia, Underground Storage Tank Regulations*** to be approved by the Division.

5.11 TIER 2B EVALUATION

Within the DCRBCA process, Tier 2B evaluation is the most complex and detailed site-specific evaluation that may be conducted. Tier 2B allows the use of different fate and transport models with sufficient documentation of the models used. Tier 2B evaluation provides the most flexibility for developing SSTLs but requires the responsible party to prepare a detailed work plan. The work plan has to be approved by the Division prior to initiating the work. Hydrologically complex sites, sites with ecological impacts, and sites with other unique characteristics or land uses may be appropriate for a Tier 2B evaluation. For an ecological evaluation, the owner should follow USEPA's guidelines for ecological risk evaluation.

5.12 CHARACTERISTICS OF THE TIERED EVALUATION

As a site moves through the DCRBCA tiered process the following may occur:

- Collection of additional site-specific data, which would increase the cost of data collection, analysis, and labor cost, but reduce the overall uncertainty about the site;
- The need for additional analysis to develop SSTLs, which would involve additional cost over the use of Tier 1 generic target levels.
- In general, the calculated Tier 2B SSTLs will be higher than the Tier 2A SSTLs because lower tier levels are designed to be more conservative than higher tier levels. Thus, the cost of corrective action to achieve the target levels should be lower.
- The need for and the extent of regulatory oversight and review for the establishment of site-specific target level will increase due to the added evaluation efforts.
- The level of uncertainty and conservatism will decrease due to the availability of more site-specific data.
- In general, the cost of assessments may increase, but the overall cost to achieve NFA should decrease.

Note that all complete routes of exposure and chemicals of concern have to be evaluated in Tier 2A and Tier 2B. Despite the above differences among the three tiers, there is one very significant similarity. Each tier will result in an equally acceptable level of protection for the site-specific human and environmental receptors, where the acceptable level of protection is defined as per ***Section 6204 (c) of the District of Columbia, Underground Storage Tank Regulations***.

Subsequent to the confirmation of a release, the Director may request the responsible party to develop and submit a corrective action plan (CAP). Alternatively a responsible party may voluntarily submit a CAP. The overall objective of a CAP or risk management plan is to ensure that:

- site conditions are protective of human health and the environment under current and reasonable anticipated future conditions, and

- recoverable non-aqueous phase hydrocarbons are not present in the soil or groundwater. Note protection of human health and the environment is based on achieving any of the tiered target levels discussed in Section 2.3 and approved by the Director.

A CAP may consist of a combination of active and/or passive remedial options as well as institutional controls acceptable to the Director. Specific requirements of the CAP are discussed in ***Section 6207 of the District of Columbia Underground Storage Tank Regulations.***

The following subsections provide information regarding a few risk management issues.

6.1 GROUNDWATER MONITORING

Within the DCRBCA process, there are two objectives of groundwater monitoring, namely (i) confirmatory monitoring and (ii) compliance monitoring.

The objective of confirmatory monitoring is to adequately understand the nature and extent of groundwater impacts and to confirm plume stability. Confirmatory monitoring may be required even when the concentrations do not exceed the tier specific target levels.

The objective of compliance monitoring is to confirm that concentrations in an exposure or compliance well do not exceed the target levels established and approved by the Director. Thus compliance monitoring is performed only after site-specific target levels have been established and approved by the Director.

Typically one or more wells may be selected as the compliance point wells. Monitoring of compliance point wells should continue until concentrations in these wells do not exceed the compliance well target concentrations and the overall trend of concentrations in these wells is decreasing. Additional monitoring may be necessary to confirm plume stability. Note the compliance well target concentrations are established such that concentrations at the POE do not exceed the groundwater standards.

The number of wells, their location, frequency of sampling, and duration of sampling will vary from site to site and will require the Director's concurrence. As a general rule, monitoring wells should be sampled quarterly for the first year after installation beyond which semi-annual, and in some cases, annual monitoring may be sufficient.

6.2 CORRECTIVE ACTION PLAN

The responsible party should prepare the CAP in accordance with the requirements of ***Section 6207 of the District of Columbia Underground Storage Tank Regulations.*** The CAP should be submitted in accordance with the schedule and format established by the Director. Within 60 days of the receipt of the CAP, the Director shall approve or disapprove the CAP. Upon approval, the responsible party should begin implementing the plan within 30 days. During the implementation phase, the responsible party should periodically evaluate the effectiveness of the corrective action plan and propose modifications as appropriate.

6.3 OWNER IMPOSED INSTITUTIONAL CONTROLS

Institutional controls are administrative and legal means by which land-use assumptions used to develop the target levels remain valid for the necessary duration. Institutional controls often limit human exposure and can be used to eliminate exposure pathways, which might otherwise require consideration under a future scenario.

The DCRBCA process will recognize the presence of existing controls in the development of the SCES. Existing implicit or explicit institutional controls help determine the future land use. For example, existing right of ways, highways, commercial complexes, will be considered in developing the SCEC prior to the selection of Tier 1 and higher target levels.

After the completion of tiered evaluation, the Director may accept owner imposed institutional controls, on a case-by-case basis as a way to eliminate certain pathways. The specific controls will be site-specific and it will be the owner/operators responsibility to convince the Director about the effectiveness and permanence of the control.

6.4 NOTIFICATION OF THE RELEASE

Under ***Section 6212 of the District of Columbia Underground Storage Tank Regulations*** for all confirmed releases which require a CAP, the Director shall provide a notice to the public directly affected by the release and the planned corrective actions.

The above notification should be made using any of the following procedures:

- Publication of the notices in local newspapers,
- Publication of the notices in the D.C. Register,
- Block advertisements,
- Public service announcements,
- Letters to individuals,
- Personal contacts by field staff, or
- Notice to Advisory Neighborhood Commissioners.

Any individual directly impacted by the release that may have migrated onto their property may request copy of relevant information pertaining to the site and if requested shall have the opportunity to comment on the CAP.

6.5 NO FURTHER ACTION PROCEDURE

When the DCRBCA evaluation has been performed and approved by the District and the site has been remediated to the established levels, the owner operator may submit a request for "**No Further Action And Case Closure Determination"** to the Director**.** This request should be accompanied by a brief site summary containing the following information;

1. Site Name,
2. DOH LUST Case #,
3. Date DCRBCA report submitted,
4. Date DCRBCA report approved,
5. Date CAP submitted,
6. Date CAP approved,
7. Site Location,
8. Site History,
9. Key Issues,
10. Site Investigation Summary,
11. Field Survey (if applicable),
12. Remedial Activities Completed (if applicable).

Typically this would be the last report submitted to the division prior to receiving a NFA or Case Closure Determination. The Director shall review the request and issue the letter if the site satisfies all the requirements for case closure. The letter would constitute that, based on the information submitted, the concentrations of COCs on or adjacent to the site do not pose an unacceptable level of risk to the public.

The NFA with conditions letter may specify some of the assumptions and site characteristics utilized in the DCRBCA evaluation. For example, the letter may indicate that the site was evaluated under the commercial land use scenario and that future site activities should be compatible with this land use.

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